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EXAMINER	
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ART UNIT	**PAPER NUMBER**
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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/727,049	KELLER, WILHELM A.
	Examiner	Art Unit
	Charles E. Cooley	1723

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *04 December 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *04152004*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

NON-FINAL OFFICE ACTION

1. This application has been assigned to Technology Center 1700, Art Unit 1723 and the following will apply for this application:

Please direct all written correspondence with the correct application serial number for this application to Art Unit 1723.

Telephone inquiries regarding this application should be directed to the Electronic Business Center (EBC) at http://www.uspto.gov/ebc/index.html or 1-866-217-9197 or to the Examiner at (571) 272-1139. All official facsimiles should be transmitted to the centralized fax receiving number 571-273-8300.

Priority

2. Receipt is acknowledged of papers submitted under 35 U.S.C. § 119, which papers have been placed of record in the file.

Information Disclosure Statement

3. Note the attached PTO-1449 form submitted with the Information Disclosure Statement filed 15 APR 2005.

Drawings

4. Applicant should verify that (1) all reference characters in the drawings are described in the detailed description portion of the specification and (2) all reference

characters mentioned in the specification are included in the appropriate drawing Figure(s) as required by 37 CFR 1.84(p)(5).

Specification

5. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

6. The Abstract of the Disclosure is objected to because:

a. the inclusion of legal phraseology such as "means" in the abstract is improper.

Correction is required. See MPEP § 608.01(b).

7. The title is acceptable.

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

9. Claims 1, 2, 3, 5, 10, 12, 13, 14, 15, 16, 17, 18, 19, and 20 are rejected under 35 U.S.C. 102(e) as being anticipated by Heusser et al. (US 6,599,008 B2).

The patent to Heusser et al. '008 discloses a method and a static mixer in Figs. 4 and 7-10 including the recited mixing elements with a transversal edge (proximate 91' in Fig. 2); transversal guide walls 92'; guide walls 2 or 83; deflecting elements with openings (the openings denoted by the flow arrows) in the mixing elements; rectangular enclosure 1 (Fig. 10); inclined webs 91; longitudinal webs 96, and obturations (any of the walls that obstruct flow).

More specifically, the patent to Heusser et al. '008 discloses a static mixer that comprises a plurality of mixing chambers which form a mixer structure. The mixing chambers are arranged one behind the other as well as adjacently in a tube along a tube axis. They can be used for mixing at least two flowable components. The mixer structure represents a modification of a basic structure. In said basic structure the mixing chambers are separated from one another by radial walls which are oriented in the direction of the tube axis and by walls which are transverse to the tube axis. Apertures between adjacent chambers in the radial walls form inputs and outputs for the components to be mixed. The modification consists of structure changes at individual locations of the basic structure. It is carried out in such a manner that a transverse dislocation of mix-resistant flow filaments results in the flowing components being mixed, with these flow filaments being mix-resistant with respect to the basic structure.

Through the transverse dislocation of the mix-resistant flow filament the latter enters into a region in which it is subject to a strong deformation and thereby becomes

more miscible. The dislocated flow filament is replaced by another one which is now in turn largely decoupled from the mixing process. It is therefore advantageous if such disturbance locations, which cause a dislocation of the respective mix-resistant flow filament, are set up at a plurality of positions of the static mixer. It is also advantageous if the disturbance locations are formed differently.

The disturbance locations as a rule have a disadvantageous effect on the mixing process in flow regions which lie outside the mix-resistant flow filament. If this is the case, then only as many disturbance locations should be provided as are necessary for a sufficient number of dislocations of the mix-resistant flow filaments. The disturbance locations can be formed such that they do not act directly on the mix-resistant flow filament, but rather indirectly in that they cause deflections in their direct region of influence which then in turn influence the mix-resistant flow filament. A design of suitable disturbance locations can be found empirically. Experiments with components which are to be mixed and which are differently colored are carried out and the results for a basic structure are compared with those of a modification of the basic structure, with it being possible to determine whether mix-resistant flow filaments have actually been dislocated.

In FIG. 1 an apparatus 100 is indicated in chain-dotted lines. The apparatus contains a static mixer 1, the mixer structure 1' of which forms a regular, non-modified basic structure 1". The mixer structure 1' is illustrated as a side view. The basic structure 1" is composed of a plurality of mixing elements which are arranged one behind the other in a tube 10; or it consists of a bundle of four chambered strings, the

mixing chambers 8 ("mix-active chambers") of which in each case extend between two closed ends 4a and 4b. Each of the mixing elements comprises two axial sections, with at least one partitioning web 2 and 3 respectively (radial walls) which subdivides the section being associated with each of the sections. The partitioning webs 2, 3 cross one another and subdivide the tube cross-section into equally large sub-areas. The sub-areas are open or covered over by deflection discs 4. One recognizes further details in the drawings, in particular in FIG. 6, which illustrates a non-modified basic structure 1" with a completely shown mixing chamber 8.

The mixing chambers 8 of the basic structure 1" are without internal installations, are equally large and are arranged with displacement with respect to one another. Two inputs 6a, 6b and two outputs 7a, 7b arranged in an alternating sequence form connections to four adjacent chambers, with material flowing between chambers as shown by arrows 6a', 6b', 7a', 7b'. Two lateral reinforcement walls 5 extend over the entire length of the mixer 1.

The apparatus 100 includes a two-chambered container 100a, namely a cartridge, with chambers 101 and 102. The latter serve for the separate reception of two flowable components A and B. A and B can be pressed in into the tube 10 (arrows A', B) through outputs of the container 100a by means of pistons 111 and 112. After a mixing of A with B in the static mixer 1, which is composed of the tube 10 and the mixer structure 1', the mixture emerges from the apparatus 100 through a nozzle 120. The cartridge 100a can comprise more than two chambers. The tube 10 can be formed as a tube part which can be placed on onto the cartridge 100a.

A section in accordance with the line II--II is illustrated in FIG. 2. The two components A and B, which have the same values for the viscosity, flow through the mixer structure 1'. Arrows in the mixing chamber 8 indicate the path of the flow (with the symbols 'circle with cross` and `circle with dot` meaning downward and upward arrows respectively with respect to the plane of the drawing). The flow pattern is drawn in accordance with results of a numerical simulation. As one sees, the flow filaments appear as layers of similar thickness; this represents good mixing.

FIG. 3 shows an illustration corresponding to that of FIG. 2, for two components A and B, the viscosity values of which differ by a factor of 100. The less viscous component B forms much narrower layers, since this component flows faster. The flow filaments propagate irregularly. A further irregularity is particularly strongly developed over a cross-section which is perpendicular to the illustrated section. These irregularities result in poor mixing.

As a result of the drawbacks that the mixing process displays, mix-resistant flow filaments result, which is visible in the mixed product, against the unfavorable influence of which the measures in accordance with the invention are directed. These measures, in the form of a modification of the basic structure, have been successful; two successful cases with in each case one modification 9 are illustrated in FIGS. 4 and 7 and, respectively, FIGS. 5 and 8. The mixer structures which are illustrated in FIGS. 6 to 8 are illustrated with only one reinforcement wall 5 for the better recognizability of the essential features.

The modification 9 in accordance with FIGS. 4 and 7 is formed by an inclined web 91 in the mixing chamber 8' which is inclined with respect to the tube axis 11 or axis of the mixer structure 1'. The web 91 connects on a radial wall 2 an input 6b to an output 7a in such a manner that the flow is deflected by the web 91 from the tube wall 10 in the direction towards tube axis 11 (arrow 91'). The reverse is also possible: a flow deflection by the web 91 from the tube axis 11 in the direction towards the tube wall 10.

The modification 9 in accordance with FIGS. 5 and 8 is formed by shortenings of the lengths of three adjacent chambers 81, 82 and 83 with a simultaneous lowering of the number of inputs or outputs. In this embodiment the pair of chambers 81 and 82, which lie one behind the other along the tube axis 11, is arranged laterally to the third chamber 83. Two apertures 7c and 92 produce a connection (arrow 92') between the two chambers of the pair 81, 82.

A modification 9 advantageously comprises a plurality of disturbance locations with modification elements 91 (first modification) or 81, 82, 83, 92 (second modification) respectively, which are preferably positioned regularly over the entire length of the static mixer 1. A non-illustrated combination of the two modification elements 91 and 81, 82, 83, 92 respectively is particularly advantageous.

Further possibilities of modifying the basic structure are illustrated in summary in FIG. 9: a) broken-out wall pieces 93, 94 and 95 which cause bypass flows (arrows 93', 94' and 95'); and b) added webs 96 which narrow the passages between mixing chambers 8.

FIG. 10 schematically shows mix-resistant flow filaments 30 and 31 with reference to a cross-section through the static mixer 1. The contours of these flow filaments are less clear than illustrated; they are toothed diffusely and are located in a further surrounding 30' and 31' respectively.

The mixer structures 11' of the described embodiments are advantageously formed monolithically; they can in particular be injection molded from a thermoplastic. The mixer structure 11' has a rectangular cross-section and comprises four adjacently arranged chamber strings. Each string forms a series of from 5 to 15 mixing chambers 8. Each chamber 8 of the basic structure has a length which is 1.5 to 2.5 times as long as a chamber width, with this width being greater than 1 mm and less than 10 mm, preferably at least 2 mm and a maximum of 5 mm.

10. Claims 1, 2, 3, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by Fleischli et al. (US 5,851,067).

The patent to Fleischli et al. '067 discloses a method and a static mixer in Figs. 1-12 including the recited mixing elements with a transversal edge (proximate 2' in Fig. 1); transversal guide walls 2'; guide walls 3 and/or 4; deflecting elements with openings (the openings denoted by the flow arrows and by a2 in Fig. 1) in the mixing elements; rectangular enclosure 10; inclined webs as seen in Fig. 3; longitudinal webs 12 (Fig. 11), and obturations (any of the walls that obstruct flow); and curved walls (Fig. 4).

More specifically, the patent to Fleischli et al. '067 discloses a static mixer in which deviations from the ideal mixing effect are at least partially eliminated. This object

is satisfied in that "re-layering chambers" (or turnover chambers) are provided in the mixer through which partial layers standing at the boundaries are relocated into the interior of the layering.

The static mixer shown in FIG. 1 comprises a mixer structure 1 which is arranged in a tube 10. The mixer structure 1 is composed of mixing elements 1', each of which consists of two separating flanges 2, 2' and two deflection plates 3, 3'. In the plane of the deflection plates 3, 3', there are two open subsurfaces 4, 4', which have also been designated as passage holes.

The geometrical construction of the mixer structure 1--see FIGS. 2 and 2a--can be described as a pack or bundle of chambered strings A, B, C and D oriented in the direction of the z-axis. The designations of the chambers are A1, A2, . . . B1, B2 . . . C1, C2, . . . and D1, D2, . . . These chambers are "mixing-active"; they each extend in the direction of the tube 10 between two closed ends e1, e2; and two mutually adjacent side walls of the mixing-active chambers contain four passages a1, b1, a2 and b2 (each with a surface marked with a cross in FIG. 2) of alternating disposition. The chamber C2 is connected via the passages a1 and b1 to the two chambers A1, B1 lying upstream as well as via the passages a2 and b2 to the two chambers A2, B2 lying downstream. All the chambers in the mixer of FIG. 1 are mixing-active. In general, however, a mixing-active chamber can also be connected to other chambers (re-layering or intermediate chambers, see further below).

The strings A and B--seen as cross-sections in FIG. 2a--have the same construction; string A can be brought to coincidence with string B by a 180 degree

rotation about the z-axis (or the centerline 5). The same relationship exists between the strings C and D. The strings of a pair A, B are connected to the respective strings of the other pair C, D via the chamber passages a1, . . . The two string pairs differ in that the chambers of the one pair are arranged so as to be displaced in the z-direction by half a chamber length with respect to those of the other pair.

How the medium to be mixed is re-directed or reformed in the chamber C2 is indicated by the arrows 6a, 6b, 7a and 7b in FIG. 1. Two medium flows emerge from the strings A and B through the entry passages a1 (arrows 6a, 6b) and b1 (arrows 7a, 7b) into the chamber C2 and thus into the string C, unite there and influence each other in their movement through the chamber C2. At the edge 20 near the passage exit a2 a first separation off of a first partial flow (arrows 6a, 7a) takes place, which passes over into string A. The remaining partial flow (arrows 6b, 7b) enters into the string B via the exit passage b2. In the ideal case there is a uniform distribution, as indicated by the arrows, with each arrow corresponding to the same amount of transported mixing material.

The chambers of the mixer structure 1 are substantially in the shape of a rectangular prism and the passages are rectangular. The walls are executed in the shape of plates. The walls need not have constant wall thicknesses, however; they can for example be executed with a wedge shape as illustrated in FIG. 3.

Curved shapes can also be used for the walls, as is illustrated in FIG. 4, in order that the pressure drop in the mixing material produced by the mixer structure be smaller than that with the mixer structure of FIG. 1.

In additional to the mixing-active chambers the mixer structure 1 contains "re-layering chambers" S1, S2 in accordance with the invention--see FIG. 5--and S1', S2' (not visible in FIG. 5). The chamber S1 has two entry passages a1 and b1 as well as an exit passage t1. The passage t1 forms the connection to an intermediate chamber T (or transfer chamber) which has only one entry, namely the passage t1, and one exit t2 (not visible). A corresponding intermediate chamber T' with an entry t1' and an exit t2' is arranged diametrically with respect to T. The intermediate chambers T and T' lead further to re-layering chambers S2' (not visible) and S2 respectively, each of which contains one entry passage and two exit passages. For S2 these passages are the passages designated by t2' and a2 and b2 respectively. The chambers S1 and S2' and the chambers S1' and S2 each form a pair connected by a transfer chamber T, T' respectively. In these chamber pairs a re-layering of the layers takes place which leads to the improvement of the mixing quality in accordance with the invention. A further mixing step takes place at the same time in the second re-layering chamber S2, S2'.

FIG. 6 shows a second embodiment of the mixer structure in accordance with the invention in which re-layering chambers S1, S2' and S1', S2, which are present pairwise, are directly adjacent. From the oblique views of FIGS. 1, 5 and 6 the interconnection of the individual chambers is difficult to see or cannot be seen in its entirety. This interconnection can readily be made recognizable by unwrapping the mixer structures 1 along their extent into a plane. Such unwrappings are shown in FIGS. 7 to 9. The two lateral margins, which extend parallel to the z-axis, are respectively

formed by the string B with the chambers B1, B2, B3, . . . in FIG. 7, by B1, T', B2, . . . in FIG. 8 and by B1, S1', B2, . . . in FIG. 9.

The meander-like lines in FIGS. 7 to 9 represent the outer wall edges of the mixer structures 1. The outer corners of the deflection plates 3, 3' (FIG. 1) are not marked; they each lie in the middle of the horizontal stretches of the meander-like lines. The flow of the mixing material is indicated by arrows: inclined arrows at the entry points of the chambers, horizontal arrows at the exit points. In FIG. 7 (cf. FIG. 1) all chambers are equivalent; they are mixing-active chambers. In FIG. 8 the chamber arrangements S1-T-S2' and S1'-T'-S2 are particularly noteworthy (cf. FIG. 5). In FIG. 9 the chamber arrangements S1-S2' and S1'-S2 are particularly noteworthy (cf. FIG. 5).

FIG. 10 shows a further means with which a contribution towards satisfying the object of the invention can be made. It is as follows: most of the passages between adjacent mixing-active chambers are laterally bounded by the tube 10; for directing the flow, some individual passages are each bounded by a rib 11 arranged at the tube 10. Mixing material that flows along the tube wall is deflected into the interior of the tube 10 by these ribs 11. The mixing quality is thereby improved.

Since, as a rule, highly viscous media are treated by the mixer in accordance with the invention, large pressure gradients arise in the direction of the z-axis of the mixer structure 1. These pressure gradients decrease when the wall thicknesses are made smaller. If the walls of the mixer structure 1 are thin, however, there is the danger that the structure will be crushed. The mixer structure 1 can be brought into a more stable form with suitable reinforcement means. FIGS. 11 and 12 show reinforcements

by strips 12 and 13 which are arranged at the periphery of the mixer structure 1 in the z-direction. Such reinforcements can naturally also be provided for mixer structures which contain no re-layering chambers in accordance with the invention.

FIGS. 1 to 12 relate to mixers whose mixing-active chambers are arranged in four strings. In FIG. 13 the two upper planes represent the boundaries between adjacent axial sections which have the mixing elements. Each of them has two open subsurfaces as well as two subsurfaces covered by deflection plates 3, 3'; and the open subsurfaces 4, 4' are arranged to be mutually displaced. The lower plane specifies the designations A, B, C and D of the four chambered strings. Corresponding remarks hold for the mixers of FIGS. 14 and 15.

Mixers in accordance with FIG. 14 contain bundles with nine strings arranged in the direction of the tube, with six of these strings, namely A, C, B, D, B' and C', comprising mixing-active chambers and the remaining three strings, which are not designated, containing intermediate chambers which produce indirect connections between mixing-active chambers. The intermediate chambers arranged in the corner strings each have--like the above named transfer chambers T and T'--two passages to adjacent chambers. The intermediate chambers of the central string each contain four such passages, which are arranged in ring shape.

Mixers in accordance with FIG. 15 contain bundles with sixteen strings arranged in the direction of the tube, with eight of these strings, namely A, C, B, D, A', B', C' and D', comprising mixing-active chambers and the remaining eight strings containing intermediate chambers which produce indirect connections between mixing-active

chambers. The intermediate chambers again each have two or four passages to adjacent chambers as in the embodiment of FIG. 14.

11. Claims 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by Streiff (US 5,944,419).

The patent to Streiff '419 discloses a method and a static mixer in Figs. 1-8 including the recited mixing elements with a transversal edge (between 2 and 3 in Fig. 5a); transversal guide walls 3; guide walls 2; deflecting elements with openings (the openings denoted by 4 or 4' in Figs. 5a and 5b) in the mixing elements; inclined webs 2' as seen in Fig. 8; longitudinal webs 35 (Fig. 8); obturations (any of the walls that obstruct flow); round enclosure 10; and curved walls as seen in Fig. 8.

More specifically, the patent to Streiff '419 discloses a static mixer with mixing elements of an especially simple form. The mixer comprises a monolithic mixing body with a series of several mixing elements placed one after the other. The mixer can easily be constructed by injection molding of plastics or by precision casting (steel), and two-part tools can be used, especially in the simplest embodiments (two-hole versions). The mixing bodies in accordance with the invention can also be constructed in a simple manner from sheet metal for example. The mixer has no channels with confusor- and diffusor-like sections or bores. Experiments showed that simple plates with holes and separating flanges which are placed on the plates yield a surprisingly good quality of mixing. Effects that were to be expected due to the lack of confusor- and diffusor-like

sections turned out to have practically no negative influence with respect to the quality of mixing.

For the mixer in accordance with the invention, tubes of arbitrary cross sections can be provided; square or circular cross-sections are, however, preferable.

Experiments were carried out with mixers in accordance with the invention whose mixing elements had 2, 3 and 4 holes each.

The mixing elements 1 and 1' of FIG. 1 arranged in a tube 10 each comprise two separating flanges 2 and 2', and two deflecting plates 3 and 3' which lie in a plane 3a, 3a' respectively indicated by the chain-dotted lines. The plane 3a lies perpendicular to the tube axis 5 and parallel to planes 2a and 2b, which define the upper edge 20 and the lower edge 21 of the separating flanges 2 respectively. The three planes 2a, 3a and 2b define and bound two sections 1a and 1b of the mixing element 1. To each section is assigned one of the two separating flanges 2 subdividing the section. The separating flanges 2 of the two sections 1a and 1b cross one another at right angles. The tube cross section is subdivided into four equal subareas by the separating flanges 2, where two of these subareas are covered by the deflecting plates 3. The two open subareas are provided as constrictions and passage holes 4 for the medium to be mixed.

The two successive mixing elements 1 and 1' are formed substantially in the same way. However, mixing element 1 represents the mirror image of mixing element 1'. The neighboring separating flanges 2 and 2' cross one another; the open subareas 4 and 4' are arranged in a mutually offset manner.

The deflecting plates 3 can also subtend an angle alpha with the cross-sectional plane 3a--see FIG. 2. This angle alpha is advantageously chosen to be not greater than 30 degrees. FIGS. 3 and 4 show further embodiments with inclined surfaces. If the axis 5 is understood to be vertical, the arrow 6 in FIGS. 2 to 4 represents the fall line of a deflecting plate 3. In FIG. 2 this arrow 6 is parallel to the upper separating flange 2. In the exemplary embodiment of FIG. 3 the arrow 6 is tangential to a circular cylinder concentric with the axis 5. In the exemplary embodiment of FIG. 4 the arrow 6 is directed radially outwards.

FIGS. 5a and 5b show mixing elements 1 and 1' in each of which two separating flanges 2 are respectively associated with a section bounded by the upper edges of the flanges 2 and the plates 3 and a section bounded by the plates 3 and the lower edges of the flanges 2, as analogous to 1a and 1b of FIG. 1 (not shown in FIGS. 5a and 5b). On both sides of each separating flange 2 is placed exactly one open subarea 4. The mixing element 1' with the open subareas 4' represents an immediately neighboring element of the mixing element 1. The open subareas 4 and 4' are arranged in a mutually offset manner. In the three-hole version (FIGS. 5a and 5b) the two mixing elements 1 and 1' are identical and not mirror imaged as in the two-hole version (FIG. 1).

For efficient manufacture of the three-hole mixing body (FIGS. 5a and 5b) by the process of injection molding, the mixing elements can be divided into two halves. The boundaries between the half elements are shown in FIGS. 5a and 5b as chain-dotted lines 7 and 7' respectively. Monolithic partial bodies each containing a series of such

half elements can be constructed simply using two-part tools. The entire mixing body (1, 1') is formed by joining together two matching monolithic partial bodies.

The longitudinal section of FIG. 6 shows the individual mixing elements 1 and 1' alternately stacked closely upon one another. Spacings between individual neighboring elements or between all elements can however also be provided. Mixing elements built in with spacing can be connected by connecting pieces to form a monolithic mixer.

In FIG. 6 the course of the flow of the medium to be mixed is also indicated by the arrows 8, 8' and 8". Arrow 8' is perpendicular to the plane of the diagram and is directed forwards; arrow 8"--also normal--is directed towards the rear. The reference symbol 9 points toward a position at which the arrows indicate the creation of two partial streams.

It is advantageous for the deflection plates 3 of each element (1, 1') to lie in a common plane. In the presence of at least two separating flanges 2 per section (three-hole version) several deflection plates 3 can be joined together to form a common plate or a single plate 30 (four-hole version), as shown in FIGS. 5a and 5b and the corresponding FIGS. 7a and 7b for the four-hole version.

In each of FIGS. 7a and 7b only the single and common deflection plate 30 or 30' is shown. The chain-dotted lines 23 represent the lower edges of the upper separating flanges. As in the previous two-hole version the neighboring mixing elements are mirror images of one another.

In place of a circular cross section, the mixer in accordance with the invention can have a cross section of any other shape, for example that of a square. The angles

of crossing between the neighboring separating flanges 2, 2' can also deviate from 90 degrees. The sections 1a and 1b (see FIG. 1) can be of different lengths. It is advantageous for the length of the sections 1a and 1b to be in the range from D/8 to D; it is preferably D/4.

FIG. 8 illustrates what deviations from the simple form described above are conceivable. In this embodiment, connecting elements 35 are placed between the spaced mixing elements 1, 1'. The separating flanges 2 have additional elements 25, 26 as strengtheners or stream deflectors. Separating flanges 2' and 2" of neighboring mixing elements 1' and 1" are fitted together at the position 29. Some of the separating flanges 2 and deflection plates 3 are nonplanar.

The mixing elements 1 and 1' have different numbers of separating flanges 2 and 2' per section 1a and 1b respectively, namely two and one respectively. One separating flange 2 has a recess 29. FIG. 8 is understood merely as illustrating individual features; this particular combination of all features listed in a single mixer does not preclude other combinations.

The tube 10 can also be shaped conically (not shown) so that it tapers in the direction of flow. In this case, the mixing bodies 1, 1' must be constructed in differing sizes corresponding to the varying cross section.

12. Claims 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 18, 19, and 20 are rejected under 35 U.S.C. 102(e) as being anticipated by Henning (US 6,773,156 B2).

The patent to Henning '156 discloses a method and a static mixer in Figs. 1-9C including the recited mixing elements with a transversal edge 24; transversal guide walls 24a; guide walls 25, 27a; deflecting elements with openings as seen in Fig. 2 in the mixing elements; inclined webs 22; obturations (any of the walls that obstuct flow); rectangular enclosure 12; and curved walls as seen in Figs. 9A-9C.

More specifically, the patent to Henning discloses a motionless mixer that includes a conduit and a flow inversion baffle disposed in the conduit in which the flow inversion baffle has a center to perimeter flow portion, a perimeter to center flow portion and a perimeter flow diverter. Fluids introduced into and flowing within the conduit are mixed together by moving the fluids flowing in the center of the fluid flow to the perimeter of flow and by also moving the fluids from the perimeter of the fluid flow to the center of flow. The mixer may also have a plurality of baffle elements. At least one baffle element may be a right-handed baffle element and at least one other baffle element may be a left-handed baffle element. The baffle elements may be integral with one another, and a sidewall may be formed integral with the baffle elements. The baffle elements may be formed by injection molding.

The motionless mixer includes a conduit, at least one flow inversion baffle disposed in the conduit and a plurality of alternating mixing baffles disposed in the conduit. The flow inversion baffle has a center to perimeter flow portion, a perimeter to center flow portion and a perimeter flow diverter. In this aspect of the invention, the center to perimeter flow portion has a chamber wall that defines a center to perimeter flow chamber having an entry and an exit, and the perimeter to center flow portion has a

chamber wall that defines a perimeter to center flow chamber having an entry and an exit. The center to perimeter flow portion, the perimeter to center flow portion and the perimeter flow diverter may be integral with one another. The perimeter flow diverter may surround the center to perimeter flow portion and define the entry to the perimeter to center flow chamber. Further, the chamber wall of the perimeter to center flow portion may define an angled baffle adjacent the flow chamber exit. In one aspect of the invention, the alternating baffle elements are right-handed and left handed baffle elements. The alternating right-handed and left-handed baffle elements may have a 90 degree twist. The conduit of the mixer may be circular, and the flow inversion baffle and the alternating baffle elements may be rounded. The baffle elements may be integral with one another, and a sidewall may be formed integral with the baffle elements. The baffle elements may be formed by injection molding.

A method of reducing fluid streaking in a motionless mixer includes providing a conduit having an inlet and an outlet, a flow inversion baffle and a plurality of alternating mixing baffles disposed in the conduit. The flow inversion baffle has a center to perimeter flow portion, a perimeter to center flow portion and a perimeter flow diverter. The method farther includes introducing a plurality of fluids to be mixed to the conduit inlet, forcing the fluids through baffles in the conduit and extruding a mixed fluid composition from the conduit outlet. In another aspect of the invention, a method of making a flow inversion baffle includes providing a set of forming tools that define the structure for a flow inversion baffle having a center to perimeter flow portion, a perimeter to center flow portion and a perimeter flow diverter, setting the forming tools to form a

flow inversion baffle mold and injecting plastic resin into the flow inversion baffle mold to form a flow inversion baffle. According to another aspect of the invention, a method of making a baffle assembly includes providing a set of forming tools that define the structure for a flow inversion baffle having a center to perimeter flow portion, a perimeter to center flow portion and a perimeter flow diverter and that further defines a plurality of alternating mixing baffles, setting the forming tools to form a mold for a baffle assembly having a flow inversion baffle and plurality of alternating mixing baffles and injecting plastic resin into the baffle assembly mold to form a baffle assembly.

Referring to FIG. 1, an embodiment of a mixer 10 of the present invention includes a conduit 12 defining an interior wall 13, an inlet 14 and an outlet 16. The mixer 10 further includes a series of alternating left-handed baffles 18, right-handed baffles 20 and one or more flow inversion baffles 21. The mixer 10 depicted in FIG. 1 is a twenty-four stage mixer having twenty-four baffle elements 18, 20, 21. There are eleven right-handed baffles 18, eleven left-handed baffles 20 and two flow inversion baffles 21. The baffles 18, 20, 21 are disposed within the conduit 12 along a central, longitudinal axis X along which inserted materials flow in a flow direction F. The left-handed and right-handed baffles 18, 20 are mirror images of one another. The baffles 18, 20 are provided with two forward, angled surfaces 22 and two rear, angled surfaces 23 (FIGS. 2-4). The front angled surfaces 22 and rear angled surfaces 23 are connected by two planar webs 24, 27 that intersect one another. In a preferred embodiment, all of the baffles (i.e., left-handed 18, right-handed 20 and flow inversion 21) are formed together as an integral string and are further integral with a pair of opposing sidewalls 15 to form a baffle

assembly 26. The sidewalls 15 provide support and rigidity to the baffle assembly 26 during insertion of the assembly 26 into the conduit 12 and during operation of the mixer 10.

Referring to FIGS. 2-4, a portion of an embodiment of a baffle assembly 26 including right and left-handed baffles 18, 20 is depicted. Referring to FIG. 3, the right-handed baffle 20 is provided with a first, generally planar web 24 that has opposing sides 24a and 24b and a second, generally planar web 27 having opposing sides 27a and 27b. The webs 24, 27 extend generally parallel to the flow direction and intersect one another. The right-handed baffle 20 is also provided with a first, forward surface 22 wherein the surface 22 is perpendicular to one side of the web 24a and at an angle to a plane perpendicular to the material flow. A second, forward surface is shown in FIG. 3 wherein the surface 22 is perpendicular to the side of the web 24b at an angle to a plane that is perpendicular to the material flow. FIG. 3 also shows a first, rear surface 23 wherein the surface is perpendicular to one side of the web 27b and at an angle to a plane that is perpendicular to the material flow. The right-handed baffle 20 also has a second, rear surface 23. The second, rear surface 23 is perpendicular to the side of the web 27a and at an angle to a plane that is perpendicular to the material flow. In addition, one of the webs 24, 27 extends past the rear angled surfaces 23 to form a rear fin 25 that extends in the flow direction.

FIG. 4 is a detailed view of a baffle designated as a left-handed baffle 18. The left-handed baffle 18 is formed as a mirror image of the right-handed baffle 20 shown in

FIG. 3. Embodiments of the invention may be formed from baffle elements employing geometries differing from those described above.

Referring to FIGS. 5A, 5B and 5C, an embodiment of a flow inversion baffle 21 of the present invention is depicted. The flow inversion baffle 21 includes a center to perimeter flow portion 30 and a perimeter to center flow portion 32. In the embodiment depicted, the center to perimeter flow portion 30 is integral with the perimeter to center flow portion 32. The flow inversion baffle 21 includes a perimeter flow diverter 34 that surrounds the center to perimeter flow portion 30 and defines an entry 36 to a perimeter to center flow chamber 48. The perimeter flow diverter 34, in this embodiment, is integral with the mixer sidewalls 15 and, when inserted in the conduit 12, also contacts the conduit wall 13. As described in detail below, the perimeter flow diverter 34 acts to direct all fluid from along the periphery of the baffle assembly 26 into the perimeter to center flow chamber entry 36. The center to perimeter portion 30 includes a chamber wall 38 which defines a center to perimeter flow chamber 40 having an entry 42 and an exit 44. The perimeter flow diverter 34 surrounds and is integral with the chamber wall 38. The perimeter to center flow portion 32 also includes a chamber wall 46 which defines the perimeter to center flow chamber 48. The perimeter to center flow chamber 48, in addition to the entry 36, has an exit 52. The perimeter to center flow portion 32 may further include an angled baffle 54 to aid in the flow inversion process. The dimensions of the flow inversion baffle 21, and in particular the dimensions of the center to perimeter flow chamber 40 and the perimeter to center flow chamber 48, may obviously be varied to accommodate the application of use and/or the production or

molding of the baffle. In a preferred embodiment, the flow inversion baffle 21 is made by an injection molding process. Referring to FIGS. 5D-F, exemplary injection molding tooling for an embodiment of a flow inversion baffle 21 is depicted. The molding tooling for this embodiment includes a first tool plate 56 and a second tool plate 58. The tool plates 56, 58 define the structure for the flow inversion baffle 21 to be formed. FIGS. 5E and 5F illustrate the cross-section of a flow inversion baffle 21 formed using tooling plates 56, 58. The flow inversion baffle 21 of the depicted embodiment is designed such that the chamber walls 38, 46 have an open top and bottom, respectively. This design accommodates the injection molding process. By having an open top chamber wall 38 and an open bottom chamber wall 46, the tool plates 56, 58 can be brought together and aligned in a relatively simple fashion to form a flow inversion baffle mold. With the mold formed, the creation of the flow inversion baffle 21 is a relatively simple process known in the art of injecting the plastic resin into the mold and allowing it to cool and form. It should be understood that the entire baffle assembly 26, including left and right-handed baffles 18, 20 and flow inversion baffles 21, could be injection molded together at one time.

Referring to FIG. 6, the mixing characteristics of a right-handed baffle 20 and a flow inversion baffle 21 of the embodiment of the mixer 10 described above are depicted. Two fluids 60a, 60b are introduced into the mixer 10 for mixing. (The fluid 60b has been spot marked along the outer edge to track the mixing of the fluids where channeling typically occurs.) As the two fluids 60a, 60b intersect the leading edge of the right-handed baffle 20, at point 62, the fluid flow is divided in half. As the divided fluid

continues to flow through the right-handed baffle 20, the material is shifted laterally by the sub-surfaces of the right-handed baffle 20 at point 64. At point 66, as the fluid leaves the trailing edge of the right-handed baffle element 20, the now mixed fluids stretch to occupy the open space in the baffle assembly 26 within the conduit 12. From the right-handed baffle 20, the mixed fluid continues to flow into the flow inversion baffle 21. As indicated at point 70A, the mixed fluid moving in the interior of the stream is captured by the wall 38 and directed into the center to perimeter flow chamber 40 through the entry 42. The mixed fluid outside of the wall 38 makes contact with the perimeter flow diverter 34. As indicated at points 70B and 70C, as the fluid continues to flow through the mixer 10, the fluid in contact with the perimeter flow diverter 34 moves up the perimeter flow diverter 34, and the fluid captured within the center to perimeter flow chamber 40 exits the center to perimeter flow chamber 40 and expands outward towards the perimeter of the baffle assembly 26 and conduit 12. As indicated at points 70C and 70D, as the fluid continues to flow through the mixer 10, the fluid in contact with the perimeter flow diverter 34 is directed into the perimeter to center flow chamber 48. As point 70D indicates, the fluid captured in the perimeter to center flow chamber 48 flows through the chamber 48. At the same time, the fluid that exited the center to perimeter flow chamber 40 and expanded is forced by the chamber wall 46 and the sidewall 15 upward around the chamber wall 46. At point 70E, the fluid from the perimeter to center flow chamber 48 exits the chamber 48 into the center of the fluid mixing stream (72) surrounded by the fluid that exited the center to perimeter flow

chamber 40 (72). As the marking spot indicates, the spot is now mixed within the interior of the fluid flow, and the streaking caused by the "channeling" effect is eliminated.

Referring to FIGS. 7A-7C and 8A-8C, other embodiments of flow inversion baffles 21 are depicted. In the embodiment in FIGS. 7A-7C, the center to perimeter flow chamber entry 42 and the perimeter to center flow chamber exit 52 are positioned in line with the flow direction F. In the embodiment in FIGS. 8A-C, the flow inversion baffle 21 is rounded to fit in a round or circular conduit 12. FIGS. 9A-9C depict another embodiment of interconnected baffles in which the baffle elements are rounded. The baffle arrangement depicted in FIGS. 9A-9C could be combined with the flow inversion baffle 21 depicted in FIGS. 8A-C to form a baffle assembly 26 for use in a round or circular conduit 12.

The baffles could employ a helical design as opposed to the embodiments described above.

Conclusion

13. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The cited prior art discloses static mixing elements.

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Charles E. Cooley whose telephone number is (571) 272-1139. The examiner can normally be reached on Mon-Fri. All official facsimiles should be transmitted to the centralized fax receiving number 571-273-8300.

15. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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